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January 8, 2004

MS APPEAL BRIEF-PATENTS  
COMMISSIONER FOR PATENTS  
P.O. BOX 1450  
Alexandria, VA 22313-1450

Attn: Board of Patent Appeals and Interferences

Re: Patent Application of Sumio KOIWA  
Serial No. 09/638,194  
Filed: August 11, 2000  
Group Art Unit - 2826  
Examiner: Johannes P. Mondt  
Docket No. S004-4061(RCE)

S I R:

Appellant respectfully requests reinstatement of the appeal corresponding to the notice of appeal filed April 14, 2003 and submits herewith, in triplicate, his supplemental brief on appeal in connection with the captioned application.

In accordance with MPEP 1208.02, appellant respectfully requests that the fee paid for the notice of appeal filed April 14, 2003 and the appeal brief filed June 23, 2003 be applied to the present appeal. Should any additional fee be required,

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COMMISSIONER FOR PATENTS

January 8, 2004

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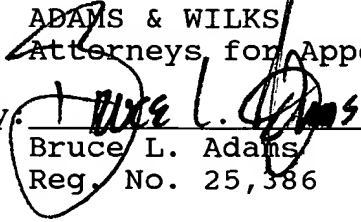
authorization is hereby given to charge any such fee to Deposit  
Account No. 01-0268.

Respectfully submitted,

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Enclosures

MAILING CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to: MS APPEAL BRIEF-PATENTS, COMMISSIONER FOR PATENTS, P.O. Box 1450, Alexandria, VA 22313-1450, on the date indicated below.

Michael Ruas

Name



Signature

January 8, 2004

Date



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

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Application of :  
Sumio KOIWA :  
Serial No. 09/638,194 : Group Art Unit: 2826  
Filed: August 11, 2000 : Examiner: Johannes P. Mondt  
For: PHOTODIODE : Docket No. S004-4061(RCE)

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MS APPEAL BRIEF-PATENTS  
COMMISSIONER FOR PATENTS  
P.O. BOX 1450  
ALEXANDRIA, VA 22313-1450

**SUPPLEMENTAL BRIEF ON APPEAL**

**S I R:**

An appeal has been taken from the final rejection of claims 1-7, 15 and 16. Appellant requests reinstatement of the appeal and presents herewith his supplemental brief in support of the appeal.

**(1) Real Party of Interest:**

The real party of interest in this appeal is Seiko Instruments Inc.

**(2) Related Appeals and Interferences:**

Appellant and appellant's counsel are aware of no other appeals or interferences which will directly affect or be directly affected by or have a direct bearing upon the Board's decision in the present appeal.

**(3) Status of Claims:**

The present application was filed with claims 1-3. Claims 4-16 were added by amendment and claims 8-14 were subsequently canceled. Claims 15-16 stand finally rejected under 35 U.S.C. §102(b) as being anticipated by Wen-Shiung Lour and Chung-Cheng Chang in Solid States Electronics, vol. 39, issue 9, pp. 1295-1298 (1986) ("Wen"). Claims 1-7<sup>1</sup> stand finally rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of appellant's prior art disclosure in Figs. 2 and 3 ("APD"). Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Song Yin (IEEE Electron Device Letters, Volume 12, No. 8, pp. 442-443 (1991)).

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<sup>1</sup> While the Examiner included claim 2 in this ground of rejection, it is clear from pages 4-5 and 10-11 of the final Office Action that the Examiner has withdrawn the rejection of claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and has rejected claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Son Yin.

The present appeal is directed to the final rejection of claims 1-7, 15 and 16. No claim stands allowed.

**(4) Status of Amendments:**

In response to a final Office Action dated January 13, 2003, an amendment after final was filed by facsimile on March 27, 2003 presenting arguments traversing the prior art rejections without further amendment of the claims. In an Advisory Action dated April 10, 2003, the Examiner indicated that the arguments presented in the amendment after final do not overcome the rejections under 35 U.S.C. §§102(b) and 103(a) set forth in the final Office Action. On April 14, 2003, appellant filed a notice of appeal appealing the January 13, 2003 final rejection of claims. A brief on appeal was timely filed on June 23, 2003.

In response to the June 23, 2003 appeal brief, the Examiner issued a final Office Action dated September 10, 2003 withdrawing the January 13, 2003 final rejection and reopening prosecution to enter a new ground of rejection of claim 2 based on the teachings of APD, Wen and the newly cited reference to Chang Song Yin.

In response to a final Office Action dated September 10, 2003, an amendment after final was filed on November 28, 2003 presenting arguments traversing the prior art rejections without further amendment of the claims. In an Advisory

Action dated December 24, 2003, the Examiner indicated that the arguments presented in the amendment after final do not overcome the rejections under 35 U.S.C. §§102(b) and 103(a) set forth in the final Office Action. No subsequent amendment after final has been filed.

**(5) Summary of Invention:**

The present invention is directed to a short-wavelength photodiode of enhanced sensitivity with low leak current.

As described in the specification (pgs. 1-3), the detection of light sensitivity in a short wavelength region by conventional photodiodes is inferior. Furthermore, the conventional photodiodes are associated with high leak current.

The present invention overcomes the drawbacks of the conventional art. Fig. 1 shows a photodiode according to the present invention embodied in independent claim 1. The photodiode comprises an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal. The optical detection portion has a semiconductor substrate 1 of a first conductive type and semiconductor layers 2a, 2b of a second conductive type formed in spaced-apart relation in a surface of the semiconductor substrate. A depletion layer 3 is formed in the semiconductor

substrate 1 by application of a reverse bias to the photodiode so as to surround the semiconductor layers 2a, 2b. An etched surface portion (denoted by X in the copy of Fig. 1 submitted herewith as Exhibit A) of the depletion layer 3 is disposed between the semiconductor layers 2a, 2b so that an interface level region of the surface of the semiconductor substrate 1 does not exist between the semiconductor layers 2a, 2b.

By the foregoing photodiode construction, the present invention provides a short-wavelength photodiode of enhanced sensitivity and with low leak current. By etching the surface portion of the depletion layer which is disposed between the semiconductor layers so that the interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, leak current is controlled without greatly influencing the photo sensitivity of the photodiode.

**(6) Issues:**

A primary issue presented by this appeal is whether the reference to Wen identically discloses the subject matter recited by each of claims 15 and 16 so as to anticipate these claims under 35 U.S.C. §102(b).

Another primary issue presented by this appeal is whether the subject matter of claims 1 and 3-7 is rendered obvious by Wen in view of APD under 35 U.S.C. §103(a).

Another primary issue presented by this appeal is whether the subject matter of claim 2 is rendered obvious by Wen in view of APD and further in view of Chang Song Yin under 35 U.S.C. §103(a).

**(7) Grouping of Claims:**

In the final Office Action, claims 15-16 were grouped together in one ground of rejection under 35 U.S.C. §102(b). Claims 1 and 3-7 were grouped together in one ground of rejection under 35 U.S.C. §103(a). Claim 2 was grouped in another ground of rejection under 35 U.S.C. §103(a).

Appellant respectfully submits that the rejected claims fall in the following groups, the claims in each group being separately patentable for the reasons given below in section (8):

- (a) Independent claim 1 along with dependent claim 3;
- (b) Dependent claim 2;
- (c) Dependent claims 4-7;
- (d) Independent claim 15; and
- (3) Dependent claim 16.



**(8) Argument:**

**Rejection Under 35 U.S.C. §102(b)**

Claims 15 and 16 stand finally rejected under 35 U.S.C. §102(b) as being anticipated by Wen. Appellant respectfully submits that claims 15-16 recite subject matter which is not disclosed or described by Wen.

Independent claim 15 is directed to a photodiode and requires an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type and a plurality of semiconductor layers of a second conductive type disposed in spaced-apart relation in a surface of the semiconductor substrate so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers. No corresponding structural combination is disclosed or suggested by the prior art of record.

Independent claim 15 recites features which are not disclosed or described by Wen. In this regard, the Board's attention is respectfully invited to Ex parte Levy, 17 USPQ2d 1461, 1462 (BPAI 1990), wherein this Board stated:

The factual determination of anticipation requires the disclosure in a single reference of every element of the claimed invention. In re Spada, 15 USPQ2d 1655 (Fed. Cir. 1990); In re Bond, 15 USPQ2d 1566 (Fed. Cir. 1990) (other citations

omitted). Moreover, it is incumbent upon the examiner to identify wherein each and every facet of the claimed invention is disclosed in the applied reference. Lindemann Maschinenfabrik GmbH v. American Hoist and Derrick, 730 F.2d 1452, 221 USPQ 481 (Fed. Cir. 1984).

Moreover, as stated by the Court of Appeals for the Federal Circuit in the case of In re Spada, 15 USPQ2d 1655, 1657 (CAFC, 1990):

Rejection for anticipation or lack of novelty requires, as the first step in the inquiry, that all the elements of the claimed invention be described in a single reference. Richardson v. Suzuki Motor Co., 9 USPQ2d 1913, 1920 (Fed. Cir.), cert. denied.

Similarly, as stated earlier by the Court of Customs and Patent Appeals in the case of In re Marshall, 198 USPQ 344, 346 (CCPA, 1978):

Rejections under 35 USC 102 are proper only when the claimed subject matter is identically disclosed or described in the prior art. In re Arkely, 59 CCPA 804, 807, 455 F.2d 586, 587, 172 USPQ 524, 526 (1972). In other words, to constitute an anticipation, all material elements recited in a claim must be found in one unit of prior art. Soundscriber Corp. v. United States, 360 F.2d 954, 960, 148 USPQ 298, 301 (Ct.cl. 1966).

Wen does not describe or disclose the subject matter of independent claim 15 and thus does not anticipate this claims.

Wen discloses a PIN photodiode. With reference to Fig. 1 of Wen which has been reproduced herewith as Exhibit B, the PIN photodiode has a P-Si substrate, an n-type ZnSe layer formed on the P-Si substrate, and two n<sup>+</sup> layers spaced-apart from one another and disposed on the n-type ZnSe layer. A depletion layer is formed in the n-type ZnSe layer above the P-Si substrate.

In contrast, independent claim 15 requires an optical detection portion having (1) a semiconductor substrate of a first conductive type and (2) a plurality of semiconductor layers of a second conductive type disposed in spaced-apart relation in a surface of the semiconductor substrate (3) so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers. As further discussed below, each of the foregoing limitations (1)-(3) recited in claim 15 is not identically disclosed or described in Wen.

With respect to limitation (1), the Examiner contends that the P-Si substrate and the i-ZnSe absorption layer in Wen together constitute and correspond to the semiconductor substrate of independent claim 15 (Final Office Action, paragraph bridging pages 5-6). Appellant respectfully disagrees with the Examiner's contention and with the Examiner's interpretation of Wen in the rejection of claim 15.

Appellant respectfully submits that one of ordinary skill in the art would recognize that only the P-Si substrate in Wen corresponds to the semiconductor substrate recited in independent claim 15. As described in parts 1-2 of Wen, the absorption layer i-ZnSe in Wen is a heteroepitaxial ZnSe thin film formed on the P-Si substrate by vapor phase epitaxy. After finishing the epitaxial growth, the  $n^+$ -ZnSe layer was achieved by driving evaporated In metal into the ZnSe layer. A P-N junction is thus formed at an interface between the P-Si substrate and the i-ZnSe layer in Wen. Accordingly, contrary to the Examiner's contention, it is evident from the disclosure in Wen that the i-ZnSe layer is a separate layer which cannot be reasonably interpreted as forming a semiconductor substrate together with the P-Si substrate. Stated otherwise, only the P-Si substrate in Wen can be reasonably interpreted as the semiconductor substrate recited in independent claim 15.

With respect to limitation (2) in independent claim 15, the Examiner contends that the pair of  $n^+$  layers in Wen correspond to the plurality of semiconductor layers of a second conductivity type disposed in spaced-apart relation in a surface of the semiconductor substrate recited in independent claim 15. Appellant respectfully disagrees with the Examiner's contention and with the Examiner's interpretation of Wen.

Appellant respectfully submits that only the i-ZnSe layer in Wen can be reasonably interpreted as corresponding to a semiconductor layer. As clearly described in part 2 of Wen's disclosure, In and Al are used to form the n<sup>+</sup> layers which are employed as ohmic contacts for the i-ZnSe layer and for an electrode (i.e., p-type Si layer) formed on the n<sup>+</sup> layers, respectively. Thus, interpreting the i-ZnSe layer as a semiconductor layer, Wen clearly does not disclose or describe a plurality of semiconductor layers of a second conductivity type disposed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 15. In Wen, the i-ZnSe layer is a single layer, not a plurality of layers which are disposed in spaced-apart relation. Furthermore, the i-ZnSe layer is formed on the P-Si substrate by vapor phase epitaxy and, therefore, is not disposed in a surface of the P-Si substrate.

Thus, contrary to the Examiner's contention, one of ordinary skill in the art would recognize that the n-type ZnSe layer, not the two n<sup>+</sup> layers, in Wen corresponds to the semiconductor layers recited in independent claim 15. The n-type ZnSe layer in Wen does not comprise a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 15.

Moreover, even if the foregoing Examiner's interpretations of Wen's PIN photodiode with respect to limitations (1) and (2) of independent claim 15 are adopted, the resulting structure of Wen's PIN photodiode does not meet the structural limitations of the photodiode recited in independent claim 15. More specifically, in Wen the n<sup>+</sup> layers, which the Examiner interprets as corresponding to the semiconductor layers of claim 15, are formed on the i-ZnSe absorption layer, which the Examiner interprets as corresponding to the semiconductor substrate together with the P-Si substrate. In contrast, independent claim 15 requires that the semiconductor layers are formed in the semiconductor substrate. Thus, even the Examiner's interpretation of Wen's PIN photodiode does not lead to the structure of the photodiode recited in independent claim 15.

With respect to limitation (3), the Examiner contends that Wen discloses a PIN photodiode in which an interface level region of the surface of a semiconductor substrate does not exist between semiconductor layers. Appellant respectfully disagrees with the Examiner's contention and with the Examiner's interpretation of Wen.

As set forth above for limitations (1) and (2), Wen does not disclose or describe a plurality of semiconductor layers disposed in spaced-apart relation in a surface of the semiconductor substrate, as recited in independent claim 15.

Accordingly, Wen does not disclose or describe that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 15. Contrary to the Examiner's contention, one of ordinary skill in the art would recognize that the n-type ZnSe layer, not the two n<sup>+</sup> layers, in Wen corresponds to the semiconductor layers recited in independent claim 15. The n-type ZnSe layer in Wen does not comprise a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 15. Since the n-type ZnSe layer in Wen does not have the specific structure of the semiconductor layers recited in independent claim 15, Wen clearly does not disclose or describe that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 15.

With respect to the Examiner's arguments in the paragraph bridging pages 6-7 of the final Office Action, the etched portion between the n<sup>+</sup> layers in Wen does not correspond to a non-existent interface level region of the surface of the semiconductor substrate between semiconductor layers, as required by independent claim 15. Appellant respectfully submits that the etched portion (i.e., portion denoted by Y in Exhibit B) of the n<sup>+</sup> layers in Wen is for the

purpose of forming an electrode pattern and removing a light obstacle. Nevertheless, even if in Wen the i-ZnSe layer is interpreted to form part of the semiconductor substrate and the n<sup>+</sup> layers are interpreted to correspond to the semiconductor layers, as proposed by the Examiner, there is no disclosure in Wen that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 15.

Moreover, the Examiner acknowledges that Wen does not specifically teach the non-existence of an interface level region of the surface of the semiconductor substrate in an area between two semiconductor layers (Final Office Action, pg. 6, lines 9-11). The Examiner contends, however, that Wen follows "exactly the same procedure" (e.g., wet etching) as described in the specification of the present invention in order to achieve the removal of the interface level region of the semiconductor substrate between the semiconductor layers. The Examiner therefore concludes that "the non-existence of an interface level region of the surface of the semiconductor substrate between the semiconductor layers" is "inherent in the device as specified by" Wen. Appellant vigorously disagrees with this contention and with the Examiner's assertion of inherency to support this contention.

The Examiner's assertion that the feature "an interface level region of the surface of the semiconductor



substrate does not exist between the semiconductor layers" in claim 15 is "inherent" in Wen is misplaced because such feature is not necessarily present in Wen as discussed above. As stated by the Federal Circuit in Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1749-50 (Fed. Cir. 1991):

To serve as an anticipation when the reference is silent about the asserted inherent characteristic, such gap in the reference may be filled with recourse to extrinsic evidence. Such evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference and that it would be so recognized by persons of ordinary skill.

As recognized by the Examiner, Wen discloses the use of standard photolithography and wet etching techniques to implement the PIN photodiode. However, contrary to the Examiner's contention, such techniques are used to remove a portion in the area immediately above the n-type ZnSe layer (note the area denoted by arrow Y in Exhibit B) corresponding to the n+ layers, not the semiconductor layers (i.e., the n-type ZnSe layer in Wen). Thus the feature "an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers" recited in claim 15 is not present in Wen, and one of ordinary skill in the art would not recognize such feature to be present.

Since Wen does not disclose or describe the foregoing features in independent claim 15, there can be no anticipation by Wen of independent claim 15 under 35 U.S.C. §102(b). That is, since each and every limitation of independent claim 15 is not found in Wen, the reference does not anticipate the claimed invention. See In re Lange, 209 USPQ 288, 293 (CCPA 1981). Furthermore, Wen does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Wen's PIN photodiode to arrive at the claimed invention.

Claim 16 depends on and contains all of the limitations of independent claim 15 and, therefore, distinguishes from the reference at least in the same manner as claim 15.

Moreover, there is a separate ground for patentability of dependent claim 16. Independent claim 15, from which claim 16 depends, requires that the semiconductor substrate is of a first conductivity type and that the semiconductor layers are of a second conductivity type. Claim 16 includes the additional limitation that the first conductivity type is different from the second conductivity type (i.e., the conductivity types of the semiconductor substrate and the semiconductor layers are different). Thus, even if the Examiner's interpretations of Wen's PIN photodiode are adopted with respect to the P-Si substrate and the i-ZnSe

layer together corresponding to the semiconductor substrate of claim 15 and the n<sup>+</sup> layers corresponding to the semiconductor layers recited in claim 15, the resulting structure of Wen's PIN photodiode does not anticipate the structural combination of the photodiode required by dependent claim 16. More specifically, adopting the Examiner's interpretation of Wen, the n-type semiconductor layers (n<sup>+</sup> layers) are disposed on the i-ZnSe absorption layer which is of the same type (i.e., n-type) as the semiconductor layers. Thus, even interpreted as proposed by the Examiner, the resulting structure of Wen's PIN photodiode would not result in a photodiode having semiconductor layers of a first conductivity type disposed in a semiconductor substrate of a second conductivity type different from the first conductivity type. limitations of the photodiode recited in dependent claim 1.

**Rejection Under 35 U.S.C. §103(a)**

Claims 1 and 3-7<sup>2</sup> were rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD. Appellant respectfully traverses this rejection and submits that the combined teachings of Wen and APD do not disclose or

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<sup>2</sup> While the Examiner included claim 2 in this ground of rejection, it is clear from pages 4-5 and 10-11 of the final Office Action that the Examiner has withdrawn the rejection of claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and has rejected claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Son Yin.

suggest the subject matter recited in independent claim 1 and dependent claims 3-7.

Independent claim 1 is directed to a photodiode and requires an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type, a plurality of semiconductor layers of a second conductive type formed in spaced-apart relation in a surface of the semiconductor substrate, and a depletion layer formed in the semiconductor substrate by application of a reverse bias to the photodiode so as to surround the semiconductor layers. Independent claim 1 further requires that the depletion layer has an etched surface portion disposed between the semiconductor layers so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers. No corresponding structural combination is disclosed or suggested by the prior art of record.

The primary reference to Wen discloses a PIN photodiode as set forth above for the rejection of claims 15-16 under 35 U.S.C. §102(b). In the statement of rejection, the Examiner contends that the P-Si substrate and the n-type ZnSe layer in Wen correspond to the semiconductor substrate in independent claim 1 and that the n<sup>+</sup> layers (i.e., ohmic contacts) correspond to the semiconductor layers in

independent claim 1. The Examiner further contends that a boundary between the portion of the  $n^+$  layers that has been etched away and the n-type ZnSe layer corresponds to the etched surface portion recited in independent claim 1. Appellant respectfully disagrees with the Examiner's contentions and with the Examiner's interpretation of Wen in the rejection of the claims.

Contrary to the Examiner's contention, one of ordinary skill in the art would recognize that only the P-Si substrate in Wen corresponds to the semiconductor substrate recited in independent claim 1. As described in parts 1-2 of Wen, the absorption layer i-ZnSe in Wen is a heteroepitaxial ZnSe thin film formed on the P-Si substrate by vapor phase epitaxy. After finishing the epitaxial growth, the  $n^+$ -ZnSe layer was achieved by driving evaporated In metal into the ZnSe layer. A P-N junction is thus formed at an interface between the P-Si substrate and the i-ZnSe layer in Wen. Accordingly, contrary to the Examiner's contention, it is evident from the disclosure in Wen that the i-ZnSe layer is a separate layer which cannot be reasonably interpreted as forming a semiconductor substrate together with the P-Si substrate. Stated otherwise, only the P-Si substrate in Wen can be reasonable interpreted as the semiconductor substrate recited in independent claim 15.

Moreover, Wen does not disclose or describe a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as recited in independent claim 1, as set forth above for the rejection of claims 15-16 under 35 U.S.C. §102(b). Contrary to the Examiner's contention, one of ordinary skill in the art would recognize that the n-type ZnSe layer, not the two n+ layers, in Wen corresponds to the semiconductor layers recited in independent claim 1. The n-type ZnSe layer in Wen does not comprise a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 1.

Wen also does not disclose or suggest a depletion layer having an etched surface portion disposed between the semiconductor layers so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 1. While acknowledging that neither Wen nor APD specifically teaches this structural feature recited in independent claim 1 (Final Office Action, pg. 9, lines 10-12), the Examiner contends that this feature "follows from the device specification" of Wen because Wen follows "exactly the same procedure" (e.g., wet etching) as described in the specification of the present invention to achieve the removal of the interface level region of the semiconductor substrate

between the semiconductor layers. Appellant vigorously disagrees with the Examiner's contention.

As recognized by the Examiner, Wen discloses the use of standard photolithography and wet etching techniques to implement the PIN photodiode. However, contrary to the Examiner's contention, such techniques are used to remove a portion in the area immediately above the n-type ZnSe layer (note the area denoted by arrow Y in Exhibit B) corresponding to the  $n^+$  layers, not the depletion layer. Stated otherwise, the etched surface portion in Wen corresponds to the  $n^+$  layers, not the depletion layer in the n-type ZnSe layer in Wen. Thus, the depletion layer in Wen clearly does not have an etched surface portion and, more specifically, an etched surface portion disposed between semiconductor layers formed in spaced-apart relation in a surface of a semiconductor substrate, and that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 1.

Moreover, even if the structure of the PIN photodiode disclosed by Wen is interpreted in the manner proposed by the Examiner, appellant respectfully submits that the resulting structure does not meet the limitations required by independent claim 1. More specifically, independent claim 1 requires that the depletion layer has an etched surface portion disposed between the semiconductor layers so that an

interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers.

While Wen discloses that the  $n^+$  layers have an etched surface portion, as discussed above, there is no disclosure or suggestion that the exposed surface of the n-type ZnSe layer (corresponding to the surface of the semiconductor substrate of independent claim 1 in accordance with the Examiner's interpretation) has been etched away. Thus, even by the Examiner's interpretation, the resulting structure of Wen would at best correspond to the structure of the conventional photodiode shown in APD (Fig. 3), where the interface level region of the semiconductor substrate has not been removed.

Moreover, as recognized by the Examiner, Wen does not disclose or suggest a depletion layer formed in the semiconductor substrate by application of a reverse bias to the photodiode so as to surround the semiconductor layers, as recited in independent claim 1. With respect to this feature, the Examiner cited APD for its disclosure of a photodiode having a depletion layer surrounding semiconductor layers. The Examiner contends that it would have been obvious to one of ordinary skill in the art to modify Wen's photodiode to incorporate this structural feature taught by APD in order to further the purpose of Wen in increasing the sensitivity of the photodiode. Appellant respectfully disagrees with the Examiner's contention.



It is unclear how the Examiner proposes to modify Wen in view of APD so that the depletion layer surrounds the semiconductor layers in Wen as interpreted by the Examiner (i.e., the  $n^+$  layers). Nevertheless, as discussed above, one of ordinary skill in the art would recognize the n-type ZnSe layer, not the  $n^+$  layers, as corresponding to the semiconductor layers in Wen. There is nothing in the references that would expressly or implicitly teach or suggest the modification urged by the Examiner and, therefore, the references do not directly establish this obviousness.

Thus one of ordinary skill in the art would not have been led to modify Wen in view of APD in the manner proposed by the Examiner in the statement of rejection. The only basis for the modifications urged by the Examiner in the rejection is appellant's own disclosure, and such hindsight rejections are improper. See, for example, Diversitech Corp. v. Century Steps, Inc., 7 USPQ2d 1315, 1318 (Fed. Cir. 1988); In re Geiger, 2 USPQ2d 1276, 1278 (Fed. Cir. 1987); Panduit Corp. v. Dennison Manufacturing Co., 227 USPQ 337, 343 (Fed. Cir. 1985); Interconnect Planning Corp. v. Feil, 227 USPQ 543, 551 (Fed. Cir. 1985).

In order to support a claim rejection based upon obviousness under 35 U.S.C. §103, the Examiner must provide an evidentiary basis establishing the obviousness of each modification. The Examiner may do this by citing a reference

which directly establishes this obviousness, or, the Examiner may otherwise set forth a line of reasoning consistent with and motivated by the cited art establishing that such modifications would have been obvious. Mere speculation or conclusory allegations are simply inadequate to meet this burden. There must be some teaching, reason, suggestion, or motivation found in the prior art references to make a combination which renders an invention obvious within the meaning of 35 U.S.C §103. See, e.g., Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d 982, 989, 18 USPQ2d 1885 (Fed. Cir. 1991).

In order to set forth a prima facie case of obviousness, the Examiner must not only demonstrate that this teaching exists in the prior art, but that it would teach all limitations of the claim. This burden cannot be met by citing references that, even if combined, fail to teach explicitly recited limitations.

Stated otherwise, in rejecting a claim as obvious under 35 U.S.C. §103, the Examiner cannot simply rely on a combination of references that teach some limitations of the claim, and make mere conclusory allegations that the combination teaches others as well.

In the instant case, the Examiner has not met his burden of establishing a prima facie case of obviousness as discussed above.

As noted by the Court of Appeals for the Federal Circuit in the case of In re Fritch, 23 USPQ2d 1780, 1783 (Fed. Cir. 1992):

'Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under section 103, teachings of references can be combined only if there is some suggestion or incentive to do so.' Although couched in terms of combining teachings found in the prior art, the same inquiry must be carried out in the context of a purported obvious 'modification' of the prior art. The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. Wilson and Hendrix fail to suggest any motivation for, or desirability of, the changes espoused by the Examiner and endorsed by the Board.

Here, the Examiner relied upon hindsight to arrive at the determination of obviousness. It is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This court has previously stated that '[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.'

As further noted by the Federal Circuit in In re Oeticker, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992):

The prima facie case is a procedural tool of patent examination, allocating the burdens of going forward as between examiner and applicant. In re Spada, 911

F.2d 705, 707 n.3, 15 USPQ2d 1655, 1657 n.3 (Fed. Cir. 1990). The term 'prima facie case' refers only to the initial examination step. In re Piasecki, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); In re Rinehart, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976). As discussed in In re Piasecki, the examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a prima facie case of unpatentability. If that burden is met, the burden of coming forward with evidence or argument shifts to the applicant.

\* \* \*

If examination at the initial stage does not produce a prima facie case of unpatentability, then without more the applicant is entitled to grant of the patent. See In re Grabiak, 769, F.2d 729, 733, 226 USPQ 870, 873 (Fed. Cir. 1985); In re Rinehart, *supra*.

In reviewing the examiner's decision on appeal, the Board must necessarily weigh all of the evidence and argument. An observation by the Board that the examiner made a prima facie case is not improper, as long as the ultimate determination of patentability is made on the entire record. In re Piasecki, 745 F.2d at 1472, 223 USPQ at 788; In re Rinehart, 531 F.2d at 1052, 189 USPQ at 147.

The Federal Circuit has therefore made it clear that the prior art must show an incentive to modify its teachings in order to render a claim obvious. Without such an incentive, a prima facie case of obviousness cannot be made.

Similarly, as this Board stated in Ex Parte Clapp, 227 USPQ 972, 973 (BPAI 1985):

To support the conclusion that the claimed combination is directed to obvious subject matter, either the references must expressly or impliedly expound the modifications urged by the examiner to have been obvious.

The same situation exists here. The Examiner has not provided an evidentiary basis establishing the obviousness of his proposed modification of Wen. There is nothing in the reference to Wen or APD that would expressly or implicitly teach or suggest the modifications urged by the Examiner and, therefore, the references do not directly establish this obviousness. Furthermore, the Examiner has not set forth a line of reasoning consistent with and motivated by the cited art establishing that such modifications would have been obvious. Again, the only basis for the modifications urged by the Examiner in the rejection is appellant's own disclosure, and such hindsight rejections are improper.

Claims 3-7 depend on and contain all of the limitations of independent claim 1 and, therefore, distinguish from the references at least in the same manner as claim 1.

Moreover there are separate grounds for patentability of dependent claims 4-7 which are directed to the specific conductivity types of the semiconductor substrate and the semiconductor layers. To support his conclusion of obviousness, the Examiner has taken official notice that since the selection of the specific conductivity types of the

semiconductor substrate and the semiconductor layers "is fully standard in the semiconductor device art", no patentable weight should be given to the specific conductivity types recited in claims 4-7. Appellant vigorously disagrees with the Examiner's reliance on only officially noticed facts to support the conclusion that it would have been obvious to one of ordinary skill in the art at the time the invention was made to select the specific conductivity types recited in claims 4-7 for the semiconductor substrate and the semiconductor layers.

Appellant respectfully submits that officially noticed facts may only play a minor role in filling evidentiary gaps to support a conclusion of obviousness and cannot provide the totality of evidence to support an obviousness rejection. In re Ahlert, 165 USPQ 418, 421 (CCPA 1970). See, also, In re Kaplan, 229 USPQ 678, 683 (Fed. Cir. 1986) ("Even if obviousness of the variation is predicated on the level of skill in the art, prior art evidence is needed to show what that level of skill was.").

In this case, the Examiner has failed to establish a recognition in the prior art, and thus knowledge thereof, of the selection of the specific conductivity types recited in claims 4-7 for the semiconductor substrate and the semiconductor layers. Thus the Examiner cannot properly rely on a conclusion of obviousness solely on official notice to

modify Wen as set forth in the Office Action to arrive at the invention recited in claims 4-7.

Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Song Yin. Appellant respectfully traverses this rejection and submits that the combined teachings of Wen, APD and Chang Song Yin do not disclose or suggest the subject matter recited in claim 2.

Wen in view of APD does not disclose or suggest the subject matter recited in independent claim 1 as set forth above for the rejection of claims 1 and 3-7 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD. Claim 2 depends on and contains all of the limitations of independent claim 1 and, therefore, distinguishes from the references at least in the same manner as claim 1.

The secondary reference to Chang Song Yin has been cited by the Examiner for its disclosure of a photodiode in which the ratio of the distance between semiconductor layers and a width of a depletion layer falls within the range recited in claim 2. However, Chang Song Yin clearly does not disclose or suggest the structural combination of the semiconductor substrate, depletion layer and semiconductor layers, including the non-existence of the interface level region of the surface of the semiconductor substrate, as recited in independent claim 1, from which claim 2 depends.

Since Chang Song Yin does not disclose or suggest the foregoing structural combination of independent claim 1, it does not cure the deficiencies of Wen as modified by APD. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

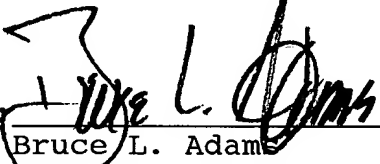


In view of the foregoing, appellant respectfully submits that claims 1-7, 15 and 16 patentably distinguish over the prior art record and, therefore, the rejection of these claims should not be sustained.

Respectfully submitted,

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(9) Appendix

Appealed claims 1-7, 15 and 16 are reproduced below in smooth form:

1. A photodiode comprising: an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type, a plurality of semiconductor layers of a second conductive type formed in spaced-apart relation in a surface of the semiconductor substrate, and a depletion layer formed in the semiconductor substrate by application of a reverse bias to the photodiode so as to surround the semiconductor layers, the depletion layer having an etched surface portion disposed between the semiconductor layers so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers.

2. A photodiode according to claim 1; wherein a distance between the semiconductor layers is 0.5 to 2 times a width of the depletion layer.

3. A photodiode according to claim 1; wherein the etched surface portion of the depletion layer comprises a wet-etched surface portion.

4. A photodiode according to claim 1; wherein the first conductivity type comprises n-type conductivity.

5. A photodiode according to claim 4; wherein the second conductivity type comprises p-type conductivity.

6. A photodiode according to claim 1; wherein the first conductivity type comprises p-type conductivity.

7. A photodiode according to claim 6; wherein the second conductivity type comprises n-type conductivity.

15. A photodiode comprising: an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type and a plurality of semiconductor layers of a second conductive type disposed in spaced-apart relation in a surface of the semiconductor substrate so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers.

16. A photodiode according to claim 15; wherein the first conductive type is different from the second conductive type.



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

-----ooo:O:ooo-----

Application of :  
Sumio KOIWA :  
Serial No. 09/638,194 : Group Art Unit: 2826  
Filed: August 11, 2000 : Examiner: Johannes P. Mondt  
For: PHOTODIODE : Docket No. S004-4061(RCE)

-----ooo:O:ooo-----

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COMMISSIONER FOR PATENTS  
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ALEXANDRIA, VA 22313-1450

SUPPLEMENTAL BRIEF ON APPEAL

S I R:

An appeal has been taken from the final rejection of claims 1-7, 15 and 16. Appellant requests reinstatement of the appeal and presents herewith his supplemental brief in support of the appeal.

(1) Real Party of Interest:

The real party of interest in this appeal is Seiko Instruments Inc.

**(2) Related Appeals and Interferences:**

Appellant and appellant's counsel are aware of no other appeals or interferences which will directly affect or be directly affected by or have a direct bearing upon the Board's decision in the present appeal.

**(3) Status of Claims:**

The present application was filed with claims 1-3. Claims 4-16 were added by amendment and claims 8-14 were subsequently canceled. Claims 15-16 stand finally rejected under 35 U.S.C. §102(b) as being anticipated by Wen-Shiung Lour and Chung-Cheng Chang in Solid States Electronics, vol. 39, issue 9, pp. 1295-1298 (1986) ("Wen"). Claims 1-7<sup>1</sup> stand finally rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of appellant's prior art disclosure in Figs. 2 and 3 ("APD"). Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Song Yin (IEEE Electron Device Letters, Volume 12, No. 8, pp. 442-443 (1991)).

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<sup>1</sup> While the Examiner included claim 2 in this ground of rejection, it is clear from pages 4-5 and 10-11 of the final Office Action that the Examiner has withdrawn the rejection of claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and has rejected claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Son Yin.

The present appeal is directed to the final rejection of claims 1-7, 15 and 16. No claim stands allowed.

**(4) Status of Amendments:**

In response to a final Office Action dated January 13, 2003, an amendment after final was filed by facsimile on March 27, 2003 presenting arguments traversing the prior art rejections without further amendment of the claims. In an Advisory Action dated April 10, 2003, the Examiner indicated that the arguments presented in the amendment after final do not overcome the rejections under 35 U.S.C. §§102(b) and 103(a) set forth in the final Office Action. On April 14, 2003, appellant filed a notice of appeal appealing the January 13, 2003 final rejection of claims. A brief on appeal was timely filed on June 23, 2003.

In response to the June 23, 2003 appeal brief, the Examiner issued a final Office Action dated September 10, 2003 withdrawing the January 13, 2003 final rejection and reopening prosecution to enter a new ground of rejection of claim 2 based on the teachings of APD, Wen and the newly cited reference to Chang Song Yin.

In response to a final Office Action dated September 10, 2003, an amendment after final was filed on November 28, 2003 presenting arguments traversing the prior art rejections without further amendment of the claims. In an Advisory

Action dated December 24, 2003, the Examiner indicated that the arguments presented in the amendment after final do not overcome the rejections under 35 U.S.C. §§102(b) and 103(a) set forth in the final Office Action. No subsequent amendment after final has been filed.

**(5) Summary of Invention:**

The present invention is directed to a short-wavelength photodiode of enhanced sensitivity with low leak current.

As described in the specification (pgs. 1-3), the detection of light sensitivity in a short wavelength region by conventional photodiodes is inferior. Furthermore, the conventional photodiodes are associated with high leak current.

The present invention overcomes the drawbacks of the conventional art. Fig. 1 shows a photodiode according to the present invention embodied in independent claim 1. The photodiode comprises an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal. The optical detection portion has a semiconductor substrate 1 of a first conductive type and semiconductor layers 2a, 2b of a second conductive type formed in spaced-apart relation in a surface of the semiconductor substrate. A depletion layer 3 is formed in the semiconductor

substrate 1 by application of a reverse bias to the photodiode so as to surround the semiconductor layers 2a, 2b. An etched surface portion (denoted by X in the copy of Fig. 1 submitted herewith as Exhibit A) of the depletion layer 3 is disposed between the semiconductor layers 2a, 2b so that an interface level region of the surface of the semiconductor substrate 1 does not exist between the semiconductor layers 2a, 2b.

By the foregoing photodiode construction, the present invention provides a short-wavelength photodiode of enhanced sensitivity and with low leak current. By etching the surface portion of the depletion layer which is disposed between the semiconductor layers so that the interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, leak current is controlled without greatly influencing the photo sensitivity of the photodiode.

**(6) Issues:**

A primary issue presented by this appeal is whether the reference to Wen identically discloses the subject matter recited by each of claims 15 and 16 so as to anticipate these claims under 35 U.S.C. §102(b).

Another primary issue presented by this appeal is whether the subject matter of claims 1 and 3-7 is rendered obvious by Wen in view of APD under 35 U.S.C. §103(a).



Another primary issue presented by this appeal is whether the subject matter of claim 2 is rendered obvious by Wen in view of APD and further in view of Chang Song Yin under 35 U.S.C. §103(a).

**(7) Grouping of Claims:**

In the final Office Action, claims 15-16 were grouped together in one ground of rejection under 35 U.S.C. §102(b). Claims 1 and 3-7 were grouped together in one ground of rejection under 35 U.S.C. §103(a). Claim 2 was grouped in another ground of rejection under 35 U.S.C. §103(a).

Appellant respectfully submits that the rejected claims fall in the following groups, the claims in each group being separately patentable for the reasons given below in section (8):

- (a) Independent claim 1 along with dependent claim 3;
- (b) Dependent claim 2;
- (c) Dependent claims 4-7;
- (d) Independent claim 15; and
- (3) Dependent claim 16.

(8) Argument:

Rejection Under 35 U.S.C. §102(b)

Claims 15 and 16 stand finally rejected under 35 U.S.C. §102(b) as being anticipated by Wen. Appellant respectfully submits that claims 15-16 recite subject matter which is not disclosed or described by Wen.

Independent claim 15 is directed to a photodiode and requires an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type and a plurality of semiconductor layers of a second conductive type disposed in spaced-apart relation in a surface of the semiconductor substrate so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers. No corresponding structural combination is disclosed or suggested by the prior art of record.

Independent claim 15 recites features which are not disclosed or described by Wen. In this regard, the Board's attention is respectfully invited to Ex parte Levy, 17 USPQ2d 1461, 1462 (BPAI 1990), wherein this Board stated:

The factual determination of anticipation requires the disclosure in a single reference of every element of the claimed invention. In re Spada, 15 USPQ2d 1655 (Fed. Cir. 1990); In re Bond, 15 USPQ2d 1566 (Fed. Cir. 1990) (other citations

omitted). Moreover, it is incumbent upon the examiner to identify wherein each and every facet of the claimed invention is disclosed in the applied reference. Lindemann Maschinenfabrik GmbH v. American Hoist and Derrick, 730 F.2d 1452, 221 USPQ 481 (Fed. Cir. 1984).

Moreover, as stated by the Court of Appeals for the Federal Circuit in the case of In re Spada, 15 USPQ2d 1655, 1657 (CAFC, 1990):

Rejection for anticipation or lack of novelty requires, as the first step in the inquiry, that all the elements of the claimed invention be described in a single reference. Richardson v. Suzuki Motor Co., 9 USPQ2d 1913, 1920 (Fed. Cir.), cert. denied.

Similarly, as stated earlier by the Court of Customs and Patent Appeals in the case of In re Marshall, 198 USPQ 344, 346 (CCPA, 1978):

Rejections under 35 USC 102 are proper only when the claimed subject matter is identically disclosed or described in the prior art. In re Arkely, 59 CCPA 804, 807, 455 F.2d 586, 587, 172 USPQ 524, 526 (1972). In other words, to constitute an anticipation, all material elements recited in a claim must be found in one unit of prior art. Soundsciber Corp. v. United States, 360 F.2d 954, 960, 148 USPQ 298, 301 (Ct.cl. 1966).

Wen does not describe or disclose the subject matter of independent claim 15 and thus does not anticipate this claims.

Wen discloses a PIN photodiode. With reference to Fig. 1 of Wen which has been reproduced herewith as Exhibit B, the PIN photodiode has a P-Si substrate, an n-type ZnSe layer formed on the P-Si substrate, and two n<sup>+</sup> layers spaced-apart from one another and disposed on the n-type ZnSe layer. A depletion layer is formed in the n-type ZnSe layer above the P-Si substrate.

In contrast, independent claim 15 requires an optical detection portion having (1) a semiconductor substrate of a first conductive type and (2) a plurality of semiconductor layers of a second conductive type disposed in spaced-apart relation in a surface of the semiconductor substrate (3) so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers. As further discussed below, each of the foregoing limitations (1)-(3) recited in claim 15 is not identically disclosed or described in Wen.

With respect to limitation (1), the Examiner contends that the P-Si substrate and the i-ZnSe absorption layer in Wen together constitute and correspond to the semiconductor substrate of independent claim 15 (Final Office Action, paragraph bridging pages 5-6). Appellant respectfully disagrees with the Examiner's contention and with the Examiner's interpretation of Wen in the rejection of claim 15.

Appellant respectfully submits that one of ordinary skill in the art would recognize that only the P-Si substrate in Wen corresponds to the semiconductor substrate recited in independent claim 15. As described in parts 1-2 of Wen, the absorption layer i-ZnSe in Wen is a heteroepitaxial ZnSe thin film formed on the P-Si substrate by vapor phase epitaxy. After finishing the epitaxial growth, the n<sup>+</sup> -ZnSe layer was achieved by driving evaporated In metal into the ZnSe layer. A P-N junction is thus formed at an interface between the P-Si substrate and the i-ZnSe layer in Wen. Accordingly, contrary to the Examiner's contention, it is evident from the disclosure in Wen that the i-ZnSe layer is a separate layer which cannot be reasonably interpreted as forming a semiconductor substrate together with the P-Si substrate. Stated otherwise, only the P-Si substrate in Wen can be reasonably interpreted as the semiconductor substrate recited in independent claim 15.

With respect to limitation (2) in independent claim 15, the Examiner contends that the pair of n<sup>+</sup> layers in Wen correspond to the plurality of semiconductor layers of a second conductivity type disposed in spaced-apart relation in a surface of the semiconductor substrate recited in independent claim 15. Appellant respectfully disagrees with the Examiner's contention and with the Examiner's interpretation of Wen.

Appellant respectfully submits that only the i-ZnSe layer in Wen can be reasonably interpreted as corresponding to a semiconductor layer. As clearly described in part 2 of Wen's disclosure, In and Al are used to form the n<sup>+</sup> layers which are employed as ohmic contacts for the i-ZnSe layer and for an electrode (i.e., p-type Si layer) formed on the n<sup>+</sup> layers, respectively. Thus, interpreting the i-ZnSe layer as a semiconductor layer, Wen clearly does not disclose or describe a plurality of semiconductor layers of a second conductivity type disposed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 15. In Wen, the i-ZnSe layer is a single layer, not a plurality of layers which are disposed in spaced-apart relation. Furthermore, the i-ZnSe layer is formed on the P-Si substrate by vapor phase epitaxy and, therefore, is not disposed in a surface of the P-Si substrate.

Thus, contrary to the Examiner's contention, one of ordinary skill in the art would recognize that the n-type ZnSe layer, not the two n<sup>+</sup> layers, in Wen corresponds to the semiconductor layers recited in independent claim 15. The n-type ZnSe layer in Wen does not comprise a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 15.

Moreover, even if the foregoing Examiner's interpretations of Wen's PIN photodiode with respect to limitations (1) and (2) of independent claim 15 are adopted, the resulting structure of Wen's PIN photodiode does not meet the structural limitations of the photodiode recited in independent claim 15. More specifically, in Wen the n<sup>+</sup> layers, which the Examiner interprets as corresponding to the semiconductor layers of claim 15, are formed on the i-ZnSe absorption layer, which the Examiner interprets as corresponding to the semiconductor substrate together with the P-Si substrate. In contrast, independent claim 15 requires that the semiconductor layers are formed in the semiconductor substrate. Thus, even the Examiner's interpretation of Wen's PIN photodiode does not lead to the structure of the photodiode recited in independent claim 15.

With respect to limitation (3), the Examiner contends that Wen discloses a PIN photodiode in which an interface level region of the surface of a semiconductor substrate does not exist between semiconductor layers. Appellant respectfully disagrees with the Examiner's contention and with the Examiner's interpretation of Wen.

As set forth above for limitations (1) and (2), Wen does not disclose or describe a plurality of semiconductor layers disposed in spaced-apart relation in a surface of the semiconductor substrate, as recited in independent claim 15.

Accordingly, Wen does not disclose or describe that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 15. Contrary to the Examiner's contention, one of ordinary skill in the art would recognize that the n-type ZnSe layer, not the two n<sup>+</sup> layers, in Wen corresponds to the semiconductor layers recited in independent claim 15. The n-type ZnSe layer in Wen does not comprise a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 15. Since the n-type ZnSe layer in Wen does not have the specific structure of the semiconductor layers recited in independent claim 15, Wen clearly does not disclose or describe that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 15.

With respect to the Examiner's arguments in the paragraph bridging pages 6-7 of the final Office Action, the etched portion between the n<sup>+</sup> layers in Wen does not correspond to a non-existent interface level region of the surface of the semiconductor substrate between semiconductor layers, as required by independent claim 15. Appellant respectfully submits that the etched portion (i.e., portion denoted by Y in Exhibit B) of the n<sup>+</sup> layers in Wen is for the



purpose of forming an electrode pattern and removing a light obstacle. Nevertheless, even if in Wen the i-ZnSe layer is interpreted to form part of the semiconductor substrate and the n<sup>+</sup> layers are interpreted to correspond to the semiconductor layers, as proposed by the Examiner, there is no disclosure in Wen that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 15.

Moreover, the Examiner acknowledges that Wen does not specifically teach the non-existence of an interface level region of the surface of the semiconductor substrate in an area between two semiconductor layers (Final Office Action, pg. 6, lines 9-11). The Examiner contends, however, that Wen follows "exactly the same procedure" (e.g., wet etching) as described in the specification of the present invention in order to achieve the removal of the interface level region of the semiconductor substrate between the semiconductor layers. The Examiner therefore concludes that "the non-existence of an interface level region of the surface of the semiconductor substrate between the semiconductor layers" is "inherent in the device as specified by" Wen. Appellant vigorously disagrees with this contention and with the Examiner's assertion of inherency to support this contention.

The Examiner's assertion that the feature "an interface level region of the surface of the semiconductor

substrate does not exist between the semiconductor layers" in claim 15 is "inherent" in Wen is misplaced because such feature is not necessarily present in Wen as discussed above. As stated by the Federal Circuit in Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1749-50 (Fed. Cir. 1991):

To serve as an anticipation when the reference is silent about the asserted inherent characteristic, such gap in the reference may be filled with recourse to extrinsic evidence. Such evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference and that it would be so recognized by persons of ordinary skill.

As recognized by the Examiner, Wen discloses the use of standard photolithography and wet etching techniques to implement the PIN photodiode. However, contrary to the Examiner's contention, such techniques are used to remove a portion in the area immediately above the n-type ZnSe layer (note the area denoted by arrow Y in Exhibit B) corresponding to the n+ layers, not the semiconductor layers (i.e., the n-type ZnSe layer in Wen). Thus the feature "an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers" recited in claim 15 is not present in Wen, and one of ordinary skill in the art would not recognize such feature to be present.

Since Wen does not disclose or describe the foregoing features in independent claim 15, there can be no anticipation by Wen of independent claim 15 under 35 U.S.C. §102(b). That is, since each and every limitation of independent claim 15 is not found in Wen, the reference does not anticipate the claimed invention. See In re Lange, 209 USPQ 288, 293 (CCPA 1981). Furthermore, Wen does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Wen's PIN photodiode to arrive at the claimed invention.

Claim 16 depends on and contains all of the limitations of independent claim 15 and, therefore, distinguishes from the reference at least in the same manner as claim 15.

Moreover, there is a separate ground for patentability of dependent claim 16. Independent claim 15, from which claim 16 depends, requires that the semiconductor substrate is of a first conductivity type and that the semiconductor layers are of a second conductivity type. Claim 16 includes the additional limitation that the first conductivity type is different from the second conductivity type (i.e., the conductivity types of the semiconductor substrate and the semiconductor layers are different). Thus, even if the Examiner's interpretations of Wen's PIN photodiode are adopted with respect to the P-Si substrate and the i-ZnSe

layer together corresponding to the semiconductor substrate of claim 15 and the n<sup>+</sup> layers corresponding to the semiconductor layers recited in claim 15, the resulting structure of Wen's PIN photodiode does not anticipate the structural combination of the photodiode required by dependent claim 16. More specifically, adopting the Examiner's interpretation of Wen, the n-type semiconductor layers (n<sup>+</sup> layers) are disposed on the i-ZnSe absorption layer which is of the same type (i.e., n-type) as the semiconductor layers. Thus, even interpreted as proposed by the Examiner, the resulting structure of Wen's PIN photodiode would not result in a photodiode having semiconductor layers of a first conductivity type disposed in a semiconductor substrate of a second conductivity type different from the first conductivity type. limitations of the photodiode recited in dependent claim 1.

**Rejection Under 35 U.S.C. §103(a)**

Claims 1 and 3-7<sup>2</sup> were rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD. Appellant respectfully traverses this rejection and submits that the combined teachings of Wen and APD do not disclose or

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<sup>2</sup> While the Examiner included claim 2 in this ground of rejection, it is clear from pages 4-5 and 10-11 of the final Office Action that the Examiner has withdrawn the rejection of claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and has rejected claim 2 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Son Yin.

suggest the subject matter recited in independent claim 1 and dependent claims 3-7.

Independent claim 1 is directed to a photodiode and requires an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type, a plurality of semiconductor layers of a second conductive type formed in spaced-apart relation in a surface of the semiconductor substrate, and a depletion layer formed in the semiconductor substrate by application of a reverse bias to the photodiode so as to surround the semiconductor layers. Independent claim 1 further requires that the depletion layer has an etched surface portion disposed between the semiconductor layers so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers. No corresponding structural combination is disclosed or suggested by the prior art of record.

The primary reference to Wen discloses a PIN photodiode as set forth above for the rejection of claims 15-16 under 35 U.S.C. §102(b). In the statement of rejection, the Examiner contends that the P-Si substrate and the n-type ZnSe layer in Wen correspond to the semiconductor substrate in independent claim 1 and that the n<sup>+</sup> layers (i.e., ohmic contacts) correspond to the semiconductor layers in

independent claim 1. The Examiner further contends that a boundary between the portion of the  $n^+$  layers that has been etched away and the n-type ZnSe layer corresponds to the etched surface portion recited in independent claim 1.

Appellant respectfully disagrees with the Examiner's contentions and with the Examiner's interpretation of Wen in the rejection of the claims.

Contrary to the Examiner's contention, one of ordinary skill in the art would recognize that only the P-Si substrate in Wen corresponds to the semiconductor substrate recited in independent claim 1. As described in parts 1-2 of Wen, the absorption layer i-ZnSe in Wen is a heteroepitaxial ZnSe thin film formed on the P-Si substrate by vapor phase epitaxy. After finishing the epitaxial growth, the  $n^+$ -ZnSe layer was achieved by driving evaporated In metal into the ZnSe layer. A P-N junction is thus formed at an interface between the P-Si substrate and the i-ZnSe layer in Wen. Accordingly, contrary to the Examiner's contention, it is evident from the disclosure in Wen that the i-ZnSe layer is a separate layer which cannot be reasonably interpreted as forming a semiconductor substrate together with the P-Si substrate. Stated otherwise, only the P-Si substrate in Wen can be reasonable interpreted as the semiconductor substrate recited in independent claim 15.

Moreover, Wen does not disclose or describe a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as recited in independent claim 1, as set forth above for the rejection of claims 15-16 under 35 U.S.C. §102(b). Contrary to the Examiner's contention, one of ordinary skill in the art would recognize that the n-type ZnSe layer, not the two n+ layers, in Wen corresponds to the semiconductor layers recited in independent claim 1. The n-type ZnSe layer in Wen does not comprise a plurality of semiconductor layers formed in spaced-apart relation in a surface of the semiconductor substrate, as required by independent claim 1.

Wen also does not disclose or suggest a depletion layer having an etched surface portion disposed between the semiconductor layers so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 1. While acknowledging that neither Wen nor APD specifically teaches this structural feature recited in independent claim 1 (Final Office Action, pg. 9, lines 10-12), the Examiner contends that this feature "follows from the device specification" of Wen because Wen follows "exactly the same procedure" (e.g., wet etching) as described in the specification of the present invention to achieve the removal of the interface level region of the semiconductor substrate

between the semiconductor layers. Appellant vigorously disagrees with the Examiner's contention.

As recognized by the Examiner, Wen discloses the use of standard photolithography and wet etching techniques to implement the PIN photodiode. However, contrary to the Examiner's contention, such techniques are used to remove a portion in the area immediately above the n-type ZnSe layer (note the area denoted by arrow Y in Exhibit B) corresponding to the n<sup>+</sup> layers, not the depletion layer. Stated otherwise, the etched surface portion in Wen corresponds to the n<sup>+</sup> layers, not the depletion layer in the n-type ZnSe layer in Wen. Thus, the depletion layer in Wen clearly does not have an etched surface portion and, more specifically, an etched surface portion disposed between semiconductor layers formed in spaced-apart relation in a surface of a semiconductor substrate, and that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers, as required by independent claim 1.

Moreover, even if the structure of the PIN photodiode disclosed by Wen is interpreted in the manner proposed by the Examiner, appellant respectfully submits that the resulting structure does not meet the limitations required by independent claim 1. More specifically, independent claim 1 requires that the depletion layer has an etched surface portion disposed between the semiconductor layers so that an



interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers.

While Wen discloses that the  $n^+$  layers have an etched surface portion, as discussed above, there is no disclosure or suggestion that the exposed surface of the n-type ZnSe layer (corresponding to the surface of the semiconductor substrate of independent claim 1 in accordance with the Examiner's interpretation) has been etched away. Thus, even by the Examiner's interpretation, the resulting structure of Wen would at best correspond to the structure of the conventional photodiode shown in APD (Fig. 3), where the interface level region of the semiconductor substrate has not been removed.

Moreover, as recognized by the Examiner, Wen does not disclose or suggest a depletion layer formed in the semiconductor substrate by application of a reverse bias to the photodiode so as to surround the semiconductor layers, as recited in independent claim 1. With respect to this feature, the Examiner cited APD for its disclosure of a photodiode having a depletion layer surrounding semiconductor layers. The Examiner contends that it would have been obvious to one of ordinary skill in the art to modify Wen's photodiode to incorporate this structural feature taught by APD in order to further the purpose of Wen in increasing the sensitivity of the photodiode. Appellant respectfully disagrees with the Examiner's contention.

It is unclear how the Examiner proposes to modify Wen in view of APD so that the depletion layer surrounds the semiconductor layers in Wen as interpreted by the Examiner (i.e., the n<sup>+</sup> layers). Nevertheless, as discussed above, one of ordinary skill in the art would recognize the n-type ZnSe layer, not the n<sup>+</sup> layers, as corresponding to the semiconductor layers in Wen. There is nothing in the references that would expressly or implicitly teach or suggest the modification urged by the Examiner and, therefore, the references do not directly establish this obviousness.

Thus one of ordinary skill in the art would not have been led to modify Wen in view of APD in the manner proposed by the Examiner in the statement of rejection. The only basis for the modifications urged by the Examiner in the rejection is appellant's own disclosure, and such hindsight rejections are improper. See, for example, Diversitech Corp. v. Century Steps, Inc., 7 USPQ2d 1315, 1318 (Fed. Cir. 1988); In re Geiger, 2 USPQ2d 1276, 1278 (Fed. Cir. 1987); Panduit Corp. v. Dennison Manufacturing Co., 227 USPQ 337, 343 (Fed. Cir. 1985); Interconnect Planning Corp. v. Feil, 227 USPQ 543, 551 (Fed. Cir. 1985).

In order to support a claim rejection based upon obviousness under 35 U.S.C. §103, the Examiner must provide an evidentiary basis establishing the obviousness of each modification. The Examiner may do this by citing a reference

which directly establishes this obviousness, or, the Examiner may otherwise set forth a line of reasoning consistent with and motivated by the cited art establishing that such modifications would have been obvious. Mere speculation or conclusory allegations are simply inadequate to meet this burden. There must be some teaching, reason, suggestion, or motivation found in the prior art references to make a combination which renders an invention obvious within the meaning of 35 U.S.C §103. See, e.g., Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d 982, 989, 18 USPQ2d 1885 (Fed. Cir. 1991).

In order to set forth a prima facie case of obviousness, the Examiner must not only demonstrate that this teaching exists in the prior art, but that it would teach all limitations of the claim. This burden cannot be met by citing references that, even if combined, fail to teach explicitly recited limitations.

Stated otherwise, in rejecting a claim as obvious under 35 U.S.C. §103, the Examiner cannot simply rely on a combination of references that teach some limitations of the claim, and make mere conclusory allegations that the combination teaches others as well.

In the instant case, the Examiner has not met his burden of establishing a prima facie case of obviousness as discussed above.

As noted by the Court of Appeals for the Federal Circuit in the case of In re Fritch, 23 USPQ2d 1780, 1783 (Fed. Cir. 1992):

'Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under section 103, teachings of references can be combined only if there is some suggestion or incentive to do so.' Although couched in terms of combining teachings found in the prior art, the same inquiry must be carried out in the context of a purported obvious 'modification' of the prior art. The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. Wilson and Hendrix fail to suggest any motivation for, or desirability of, the changes espoused by the Examiner and endorsed by the Board.

Here, the Examiner relied upon hindsight to arrive at the determination of obviousness. It is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This court has previously stated that '[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.'

As further noted by the Federal Circuit in In re Oeticker, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992):

The prima facie case is a procedural tool of patent examination, allocating the burdens of going forward as between examiner and applicant. In re Spada, 911

F.2d 705, 707 n.3, 15 USPQ2d 1655, 1657 n.3 (Fed. Cir. 1990). The term 'prima facie case' refers only to the initial examination step. In re Piasecki, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); In re Rinehart, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976). As discussed in In re Piasecki, the examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a prima facie case of unpatentability. If that burden is met, the burden of coming forward with evidence or argument shifts to the applicant.

\* \* \*

If examination at the initial stage does not produce a prima facie case of unpatentability, then without more the applicant is entitled to grant of the patent. See In re Grabiak, 769, F.2d 729, 733, 226 USPQ 870, 873 (Fed. Cir. 1985); In re Rinehart, *supra*.

In reviewing the examiner's decision on appeal, the Board must necessarily weigh all of the evidence and argument. An observation by the Board that the examiner made a prima facie case is not improper, as long as the ultimate determination of patentability is made on the entire record. In re Piasecki, 745 F.2d at 1472, 223 USPQ at 788; In re Rinehart, 531 F.2d at 1052, 189 USPQ at 147.

The Federal Circuit has therefore made it clear that the prior art must show an incentive to modify its teachings in order to render a claim obvious. Without such an incentive, a prima facie case of obviousness cannot be made.

Similarly, as this Board stated in Ex Parte Clapp, 227 USPQ 972, 973 (BPAI 1985):

To support the conclusion that the claimed combination is directed to obvious subject matter, either the references must expressly or impliedly expound the modifications urged by the examiner to have been obvious.

The same situation exists here. The Examiner has not provided an evidentiary basis establishing the obviousness of his proposed modification of Wen. There is nothing in the reference to Wen or APD that would expressly or implicitly teach or suggest the modifications urged by the Examiner and, therefore, the references do not directly establish this obviousness. Furthermore, the Examiner has not set forth a line of reasoning consistent with and motivated by the cited art establishing that such modifications would have been obvious. Again, the only basis for the modifications urged by the Examiner in the rejection is appellant's own disclosure, and such hindsight rejections are improper.

Claims 3-7 depend on and contain all of the limitations of independent claim 1 and, therefore, distinguish from the references at least in the same manner as claim 1.

Moreover there are separate grounds for patentability of dependent claims 4-7 which are directed to the specific conductivity types of the semiconductor substrate and the semiconductor layers. To support his conclusion of obviousness, the Examiner has taken official notice that since the selection of the specific conductivity types of the

semiconductor substrate and the semiconductor layers "is fully standard in the semiconductor device art", no patentable weight should be given to the specific conductivity types recited in claims 4-7. Appellant vigorously disagrees with the Examiner's reliance on only officially noticed facts to support the conclusion that it would have been obvious to one of ordinary skill in the art at the time the invention was made to select the specific conductivity types recited in claims 4-7 for the semiconductor substrate and the semiconductor layers.

Appellant respectfully submits that officially noticed facts may only play a minor role in filling evidentiary gaps to support a conclusion of obviousness and cannot provide the totality of evidence to support an obviousness rejection. In re Ahlert, 165 USPQ 418, 421 (CCPA 1970). See, also, In re Kaplan, 229 USPQ 678, 683 (Fed. Cir. 1986) ("Even if obviousness of the variation is predicated on the level of skill in the art, prior art evidence is needed to show what that level of skill was.").

In this case, the Examiner has failed to establish a recognition in the prior art, and thus knowledge thereof, of the selection of the specific conductivity types recited in claims 4-7 for the semiconductor substrate and the semiconductor layers. Thus the Examiner cannot properly rely on a conclusion of obviousness solely on official notice to

modify Wen as set forth in the Office Action to arrive at the invention recited in claims 4-7.

Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD and further in view of Chang Song Yin. Appellant respectfully traverses this rejection and submits that the combined teachings of Wen, APD and Chang Song Yin do not disclose or suggest the subject matter recited in claim 2.

Wen in view of APD does not disclose or suggest the subject matter recited in independent claim 1 as set forth above for the rejection of claims 1 and 3-7 under 35 U.S.C. §103(a) as being unpatentable over Wen in view of APD. Claim 2 depends on and contains all of the limitations of independent claim 1 and, therefore, distinguishes from the references at least in the same manner as claim 1.

The secondary reference to Chang Song Yin has been cited by the Examiner for its disclosure of a photodiode in which the ratio of the distance between semiconductor layers and a width of a depletion layer falls within the range recited in claim 2. However, Chang Song Yin clearly does not disclose or suggest the structural combination of the semiconductor substrate, depletion layer and semiconductor layers, including the non-existence of the interface level region of the surface of the semiconductor substrate, as recited in independent claim 1, from which claim 2 depends.



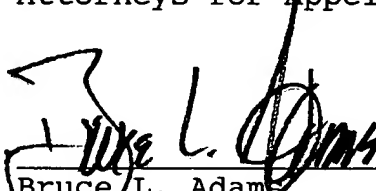
Since Chang Song Yin does not disclose or suggest the foregoing structural combination of independent claim 1, it does not cure the deficiencies of Wen as modified by APD. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, appellant respectfully submits that claims 1-7, 15 and 16 patentably distinguish over the prior art record and, therefore, the rejection of these claims should not be sustained.

Respectfully submitted,

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(9) Appendix

Appealed claims 1-7, 15 and 16 are reproduced below in smooth form:

1. A photodiode comprising: an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type, a plurality of semiconductor layers of a second conductive type formed in spaced-apart relation in a surface of the semiconductor substrate, and a depletion layer formed in the semiconductor substrate by application of a reverse bias to the photodiode so as to surround the semiconductor layers, the depletion layer having an etched surface portion disposed between the semiconductor layers so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers.

2. A photodiode according to claim 1; wherein a distance between the semiconductor layers is 0.5 to 2 times a width of the depletion layer.

3. A photodiode according to claim 1; wherein the etched surface portion of the depletion layer comprises a wet-etched surface portion.

4. A photodiode according to claim 1; wherein the first conductivity type comprises n-type conductivity.

5. A photodiode according to claim 4; wherein the second conductivity type comprises p-type conductivity.

6. A photodiode according to claim 1; wherein the first conductivity type comprises p-type conductivity.

7. A photodiode according to claim 6; wherein the second conductivity type comprises n-type conductivity.

15. A photodiode comprising: an optical detection portion for detecting an optical signal and outputting a photoelectric conversion signal, the optical detection portion having a semiconductor substrate of a first conductive type and a plurality of semiconductor layers of a second conductive type disposed in spaced-apart relation in a surface of the semiconductor substrate so that an interface level region of the surface of the semiconductor substrate does not exist between the semiconductor layers.

16. A photodiode according to claim 15; wherein the first conductive type is different from the second conductive type.